REMARKS

Claims 1, 3-6, 8-11 and 13-16 are pending in this application. By this Amendment, claims 2, 7 and 12 are cancelled. Claims 1, 3 and 8 are amended and new claims 15-16 are added. No new matter is added.

Allowable Subject Matter

Applicants thank the Examiner for the indication that claims 5, 6, 10, 11, 13 and 14 would be allowable if rewritten in independent form. Because the remainder of the claims are allowable at least for the reasons discussed below, it is respectfully submitted that the entire application is in condition for allowance.

Section 112, Second Paragraph, Rejection

The Office Action rejects claims 2, 7 and 12 under 35 U.S.C. § 112, second paragraph, as being indefinite for containing asserted informalities. Applicants respectfully submit that this rejection is rendered moot with the cancellation of claims 2, 7 and 12. Reconsideration and withdrawal of the rejection of claims 2, 7 and 12 under 35 U.S.C. § 112, second paragraph, are respectfully requested.

Section 103 Rejection

The Office Action rejects claims 1-4, 7-9 and 12 under 35 U.S.C. § 103(a) as being obvious over Ap (U.S. Patent No. 6,448,535) in view of Greenhill (U.S. Patent No. 6,223,844). This rejection is traversed as it may apply to the amended claims.

The present claims are directed to a cooling system for a fuel cell powered vehicle and fuel cell powered vehicle including a cooling apparatus. The present claims require, *inter alia*, primary and secondary circulation passages arranged to allow primary and secondary coolants to be circulated through primary and secondary circulation pumps, respectively. The primary and secondary pumps are connected to and driven with ratable shafts of a single pump drive motor, respectively. Ap discloses a cooling device for an electric vehicle powered by a fuel cell. As the Office Action correctly notes, Ap does not disclose primary and secondary pumps driven by a single motor. However, the Office Action asserts that Greenhill shows a single matter .120 driving pumps 140 and 146.

However, Applicants respectfully note that Greenhill et al. specifically disclose that a "traction motor 120 [that] is operatively connected to drive various auxiliary devices including fluid supply devices for directing fluid streams to the fuel cell stacks...Traction motor 120 is also mechanically coupled to drive a plurality of mechanical loads, including an air compressor...[and] is also mechanically coupled to drive pumps 140 and 146 which circulate coolant fluids in [a] fuel cell cooling system 148" (see col. 5, lines 6-66 and col. 6, lines 5-6 and 16-18)

In order to expedite prosecution of this application, Applicants have amended claims 1, 3 and 8 to even more clearly define that the primary circulation pump is connected to and driven with a first rotatable shaft of a pump drive motor and the secondary circulation pump is connected to and driven with a second rotatable shaft of the pump drive motor. Nowhere do Greenhill et al. or Ap teach or suggest that primary

and secondary circulation pumps be driven by different rotatable shafts of the same pump drive motor, as is required by the present claims.

Because the Greenhill et al. traction motor drives a plurality of pumps at a single shaft (see Figure 3), power take off mechanism 205 driven by a belt or the like is required. This results in an increased size of the traction motor.

On the contrary, the presently claimed invention does not require such a large power take off mechanism. In the arrangement as claimed in claims 1, 3 and 8 the cooling system can be reduced in size.

Thus, for at least the above reasons, reconsideration and withdrawal of the rejection of claims 1-4, 7-9 and 12 under 35 U.S.C. § 103 (a) are respectfully requested.

New Claims 15-16

New claim 15 defines that the primary circulation pump, the secondary circulation pump, and the pump drive motor are arranged collinearly. In this arrangement, the cooling system can be reduced in size when compared with the arrangement of, for example, Greenhill et al.

New claim 16 specifies the construction of the pumps for circulating a predetermined amount of coolant on the premise that the optimum mutual ratio has been already determined.

Claim 16 includes the feature in that flow rates of the primary and secondary circulation pumps can be differentiated. This can be achieved by varying the number of blades of the impeller and/or the diameter of the impeller, and the like. With the provision of two different impellers at both sides of the motor, even though the primary

and secondary pumps are connected in series (rotated at the same rotational speed), it is possible to design the flow rates of the primary and secondary circulation pumps in consideration of characteristics of coolant and heat discharging capacity of the heat exchanger.

New claim 16 thus defines that the primary circulation pump and the secondary circulation pump are constructed such that the flow rates of the primary and secondary circulation pumps are differentiated. This construction allows the cooling system to be reduced in size and to vary the flow rates of the primary and secondary circulation pumps while being rotated at the same rotational speed.

Conclusion

Applicants respectfully submit that this application is in condition for allowance and such action is earnestly solicited. If the Examiner believes that anything further is desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the telephone number listed below to schedule a personal or telephone interview to discuss any remaining issues.

Please charge any fee deficiency or credit any overpayment to Deposit Account No. 01-2300, making reference to Attorney Docket No. 106145-00018.

Respectfully submitted,

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Attachments: Marked-Up Copy of Amended Paragraphs from Specification
Amended Claims Marked-Up To Show Changes

MARKED-UP COPY OF AMENDED PARAGRAPHS FROM SPECIFICATION

Please amend the Specification as follows:

Please replace the paragraph extending from page 17, line 7 to page 17, line 25 with the following new paragraph:

--When the temperature of the primary coolant, which passes through the thermostat-controlled valve 17 of the primary circulation passage 12, reaches at the temperature of 85°C and the warm-up of the fuel cell 1 is completed, the thermostat-controlled valve 17 opens the flow path at the outlet side of the primary heat exchanger 15 and the primary coolant circulates in the primary circulation passage 12 through the primary circulation pump 11, the coolant flow passage C12 of the fuel cell 1, the primary heat exchanger 15 and the thermostat-controlled valve 17. In addition, the primary coolant, which circulates through the primary heat exchanger 15, flows through the coolant flow passage C12 of the fuel cell 1 and absorbs heat produced thereby while cooling the same, allowing the primary heat exchanger 15 to achieve heat exchange with the secondary coolant of the secondary circulation passage 14 for thereby discharging heat. Thus, the temperature of the primary coolant is maintained at 85°C at the [he] inlet side of the primary heat exchanger 15 and is maintained at 75°C at the outlet side of the primary heat exchanger 15.--

Please replace the paragraph extending from page 17, line 26 to page 18, line 23 with the following new paragraph:

--On the other hand, the secondary coolant flows first from the secondary circulation pump 13 through the primary heat exchanger 15 of the first circulation flow

passage 14A and the intercooler 3D into the second heat exchanger 16 and also flows through the water jacket (not shown) of the electric vehicle motor 2 of the secondary circulation flow passage 14B, the water jacket (not shown) of the power drive unit 8, the water jacket (not shown) of the drive motor 3E and water jacket (not shown) formed in the heat sink of the output power current control device 6 into the secondary heat exchanger 16. Then, the secondary coolant circulates into the secondary circulation pump 13. When circulated, the secondary coolant absorbs heat in heat exchange with the primary coolant of the primary circulation passage 12 via the primary heat exchanger 15. When the secondary coolant passes through the intercooler 3D, the secondary coolant absorbs heat in heat exchange with air compressed with the supercharger 3C of the air supply system 3 and, also, cools the electric vehicle motor 2, the drive motor 3E, the power drive unit 8 and the output power current control device 6 while absorbing heat, discharging heat in heat exchange with the flow of outside air drawn by the electric cooling fan 19 or air flow created during traveling of the vehicle. In this manner, the temperature of the secondary coolant is maintained at 70°C at the inlet side of the secondary [primary] heat exchanger 16 [15] and at 60°C at the outlet side of the secondary [primary] heat exchanger 16 [15].–

Please replace the paragraph extending from page 20, line 26 to page 21, line 11 with the following new paragraph:

--The secondary circulation passage 14 includes a main circulation flow passage 14C wherein the secondary coolant is circulated through the secondary circulation pump 13, the first heat exchanger 15, the intercooler 3D and the second heat

exchanger 16 and the second circulation pump 13 [heat exchanger 16]. Further, the secondary circulation passage 14 includes a sub-circulation flow passage 14D wherein the secondary coolant is circulated from the secondary circulation pump 13 through the third heat exchanger 21, the electric vehicle motor 2, which is the source of heat, the power drive unit 8, the drive motor 3E of the supercharger 3C, the output power current control device 6 and the second heat exchanger 16 to the secondary circulation pump 13.--

Please replace the paragraph extending from page 21, line 23 to page 22, line 10 with the following new paragraph:

--The first heat exchanger 15 is a liquid type heat exchanger adapted to cool the primary coolant, which is circulated through the primary circulation passage 12, with the use of the secondary coolant which is circulated through the main circulation flow passage 14C [14A] of the secondary passage 14. Further, the second heat exchanger 16 is an air-cooling type heat exchanger equipped with the electric cooling fan 19, wherein the secondary coolant, which is circulated through the secondary circulation passage 14, is cooled with air flow created by the electric cooling fan19. Furthermore, the third heat exchanger 21 is an air-cooling type heat exchanger equipped with the electric cooling fan 22 wherein the secondary coolant, which is circulated through the sub-circulation flow passage 14D [14B], is cooled with air flow created by the electric cooling fan 22.--

Please replace the paragraph extending from page 22, line 21 to page 23, line 18 with the following new paragraph:

--That is, under conditions wherein the pump drive motor 20 is rotating at a prescribed speed and the second and third heat exchangers 16 and 21 discharge heat at the prescribed temperature in heat exchange with the given amount of air flow and the fuel cell 1 generates the maximum power output, the flow rate of the primary circulation pump 11 is determined such that the temperature difference between the temperature of the primary coolant flowing through the inlet [outlet] side of the first heat exchanger 15 and the temperature of the primary coolant flowing through the outlet of the first heat exchanger 15 remains within a prescribed value (that is ,for example, 10°C). Also, the flow rate of the secondary circulation pump 13 is determined such that the temperature of the primary coolant flowing through the outlet side of the first heat exchanger 15 remains within the prescribed value (that is, for example, 75°C). In particular, the ratio of the flow rates of the primary and secondary circulation pumps 11 and 13 is determined such that the temperature of the primary coolant flowing at the inlet side of the first heat exchanger 15 remains at 85°C, the temperature of the primary coolant flowing at the outlet side of the first heat exchanger 15 remains at 75°C, the temperature of the secondary coolant flowing through the outlet [inlet] side of the second heat exchanger 16 remains at 60°C and the temperature of the secondary coolant flowing through the inlet [outlet] side of the second heat exchanger 16 remains at 70°C.--

Please replace the paragraph extending from page 27, line 14 to page 28, line 3 with the following new paragraph:

--On the other hand, since the second preferred embodiment of the cooling system of the fuel cell powered vehicle includes the first heat exchanger 15 which functions as a heat discharge unit [heating device] for the primary coolant which cools the fuel cell 1, and the second and third heat exchangers which function as heat discharging units for the secondary coolant which cools the heat generating source composed of the electric vehicle motor 2, the drive motor 3E of the supercharger 3C, the power drive unit 8 and the output power current control unit 6, it is possible to prevent the heat exchangers to be largely sized while avoiding an increased size of the cooling system. In addition, since the first heat exchanger 15 is arranged in a configuration wherein the primary coolant of the primary circulation passage 12 is heat exchanged with the secondary coolant of the secondary circulation passage 14, it is possible to avoid the flow path of the cooling system from being unduly extended in length.–

AMENDED CLAIMS MARKED-UP TO SHOW CHANGES

Please cancel claims 2, 7 and 12 without prejudice to or disclaimer of the subject matter contained therein.

Please amend claims 1, 3 and 8 as follows:

1. (Amended) A cooling system for a fuel cell powered vehicle wherein a fuel cell is mounted as a power source of an electric vehicle motor, the cooling system comprising:

a primary circulation passage arranged to allow primary coolant to be circulated through a primary circulation pump to cool the fuel cell;

a secondary circulation passage arranged to circulate secondary coolant through a secondary circulation pump;

a primary heat exchanger for achieving heat exchange between the primary coolant and the secondary coolant; and

a secondary heat exchanger for achieving heat exchange between the secondary coolant and the flow of outside air;

wherein the primary circulation pump is connected to and driven with a first rotatable shaft of a pump drive motor and the [and] secondary circulation pump [pumps are] is connected to and driven with a second rotatable [shafts] shaft on an opposite side of [a single] the pump drive motor.

3. (Amended) A cooling system for a fuel cell powered vehicle having a fuel cell serving as a power source for propelling an electric vehicle motor, the cooling system comprising:

a primary circulation passage connected to the fuel cell and including a primary circulation pump for circulating primary coolant in the primary circulation passage to maintain the temperature of the fuel cell at a given temperature;

a first heat exchanger having first and second flow passages, with the first flow passage being located in the primary circulation passage;

a secondary circulation passage connected to a heat generating source composed of at least the electric vehicle motor and including a secondary circulation pump for circulating secondary coolant in the secondary circulation passage, with the secondary circulation passage being located in the second flow passage of the first heat exchanger to achieve heat exchange between the primary coolant and the secondary coolant; and

a single pump drive motor including a first rotatable shaft [shafts] connected to and [drive] driving the primary pump and a second rotatable shaft connected and driving the secondary circulation pump [pumps, respectively].

8. (Amended) A fuel cell powered vehicle comprising:

a fuel cell serving as a power source;

an electric vehicle motor powered by the fuel cell for propelling the vehicle;

a primary circulation passage connected to the fuel cell and including a primary circulation pump for circulating primary coolant in the primary circulation passage to maintain the temperature of the fuel cell at a given temperature;

a first heat exchanger having first and second flow passages, with the first flow passage being located in the primary circulation passage;

a secondary circulation passage connected to a heat generating source composed of at least the electric vehicle motor and including a secondary circulation pump for circulating secondary coolant in the secondary circulation passage, with the secondary circulation passage being located in the second flow passage of the first heat exchanger to achieve heat exchange between the primary coolant and the secondary coolant; and

a single pump drive motor including a first rotatable shaft [shafts] connected to and [drive] driving the primary pump and a second rotatable shaft connected and driving the secondary circulation pump [pumps, respectively].